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Racing Against the Vocabulary Gap: Matthew Effects in Early Vocabulary Instruction and Intervention

Michael D. Coyne[1], D. Betsy McCoach[1], Sharon Ware[2], Christy R. Austin[3], Susan M. Loftus-Rattan[4], and Doris L. Baker[5]

Abstract

We investigated whether individual differences in overall receptive vocabulary knowledge measured at the beginning of the year moderated the effects of a kindergarten vocabulary intervention that supplemented classroom vocabulary instruction. We also examined whether moderation would offset the benefits of providing Tier-2 vocabulary intervention within a multitiered-system-of-support (MTSS) or response-to-intervention framework. Participants included students from two previous studies identified as at risk for language and learning difficulties who were randomly assigned in clusters to receive small-group vocabulary intervention in addition to classroom vocabulary instruction (n = 825) or to receive classroom vocabulary instruction only (n = 781). A group of not-at-risk students (n = 741) who received classroom vocabulary instruction served as a reference group. Initial vocabulary knowledge measured at pretest moderated the impact of intervention on experimenter-developed measures of expressive vocabulary learning and listening comprehension favoring students with higher initial vocabulary knowledge. Tier-2 intervention substantially counteracted the Matthew effect for target word learning. Intervention effects on listening comprehension depended on students' initial vocabulary knowledge. Implications present benefits and challenges of supporting vocabulary learning within an MTSS framework.

Keith Stanovich introduced the "Matthew effect" to discussions of reading over 30 years ago. He described the Matthew effect as the

> facilitation of further learning by a previously existing knowledge base that is rich and elaborated. A person with more expertise has a larger knowledge base, and the large knowledge base allows that person to acquire even greater expertise at a faster rate. (Stanovich, 1986, p. 381)

This phenomenon is described clearly and simply by the biblical adage from the book of Matthew declaring that while the rich get richer, the poor get poorer.

Matthew Effects and the Vocabulary Gap

Although the Matthew effect has been used to describe patterns of learning and response across many areas of education (e.g., Merton,

[1]University of Connecticut
[2]University of St. Joseph
[3]University of Texas, Austin
[4]University of Rhode Island
[5]Southern Methodist University

Corresponding Author:
Michael D. Coyne, University of Connecticut, 249 Glenbrook Rd. U3064, Storrs, CT 06269, USA.
E-mail: mike.coyne@uconn.edu

1988; Shaywitz et al., 1995), Stanovich (1986) initially identified vocabulary development as perhaps the best illustration of this powerful and self-perpetuating mechanism (e.g., Penno, Wilkinson, & Moore, 2002). Students who have early experiences in rich oral language environments develop larger and more elaborated vocabularies. These students are then able to leverage their existing vocabulary knowledge to acquire and retain new knowledge during learning opportunities in school, first during classroom oral language interactions and then through wide independent reading. Moreover, because of accumulated successful learning experiences, these students are more likely to seek out opportunities to read and engage in oral language interactions, accelerating the process. Students with fewer early experiences with language, however, start school with less developed vocabularies and, as a result, acquire less new vocabulary knowledge during learning opportunities in school. Because these students often have negative learning experiences, they may avoid reading and oral language activities in school, increasing the gap between themselves and their peers with more developed vocabulary knowledge.

The bottom-line impact of the Matthew effect is that students with larger initial vocabularies get more exposure to new vocabulary through increased oral language and reading experiences and are better able to learn from those experiences.

Stanovich (1986) described this process as a reciprocal causal relationship; individual differences in overall vocabulary knowledge cause differential efficiency in acquiring new vocabulary during learning opportunities, and this differential vocabulary learning in turn causes further individual differences in vocabulary knowledge (see also Sternberg, 1985). The bottom-line impact of the Matthew effect is that students with larger initial vocabularies get more exposure to new vocabulary through increased oral language and reading experiences and are better able to learn from those experiences. This is the mechanism that explains the emergence and widening of vocabulary gap.

Hart and Risley's (1995) seminal research provided clear and compelling evidence that this vocabulary gap appears early, during the first years of children's lives, and is associated with meaningful early differences in the quantity and quality of language interactions between children and caregivers (see also Hoff, 2013). By the start of formal schooling, children with more exposure to, and experience with, language know thousands more word meanings than their classmates with less language experience. Compounding this, Biemiller and Slonim's (2001) research suggested that this vocabulary gap only continues to grow larger in the early grades, with the gap growing the fastest before Grade 3.

Vocabulary Instruction in the Early Grades

The growth of the vocabulary gap in the early grades is explained primarily by incidental learning (Nagy & Herman, 1987; Sternberg, 1987)—exposure to new vocabulary through naturalistic learning opportunities at home and school. Moreover, observational research suggests that very little intentional vocabulary instruction takes place in the primary grades (Wanzek, 2014). In other words, business-as-usual practice in schools contributes to the widening of the vocabulary gap, rather than narrowing it. According to Biemiller (2001), "educators do virtually nothing before grade 3 or 4 to facilitate real vocabulary growth. By then it is too late for many children" (p. 28) Because of the vocabulary gap and the lack of intentional vocabulary instruction in primary grades, researchers like Biemiller challenged educators and researchers to focus on improving vocabulary instruction in the early grades with a sense of urgency.

It was during this time that our team began a program of research to teach vocabulary to kindergarten students at risk for experiencing language and learning difficulties (Coyne et al., 2010; Coyne, McCoach, & Kapp, 2007; Coyne, McCoach, Loftus, Zipoli, & Kapp, 2009). Our goal was to develop and evaluate an instructional approach for directly teaching vocabulary to young school-age students to try to counteract the vocabulary gap, at least for words that were targeted for instruction.

There are limitations to an approach that focuses on direct instruction of target vocabulary words, chiefly the inability to teach directly even a small percentage of the vocabulary that most students are learning incidentally (Anderson & Nagy, 1993; Nagy & Herman, 1987). Despite limitations, there are also clear benefits of direct and explicit vocabulary instruction, especially for students with less developed vocabulary knowledge (Baker, Simmons, & Kameenui, 1998). Although the number of vocabulary words that can be taught directly is limited, the words that can be taught can make up a significant and meaningful percentage of words that some students will learn during a school year (Biemiller, 2001). If teachers select words carefully, for example, high-leverage academic vocabulary that occurs often in the language of school and text (Beck, McKeown, & Kucan, 2002; Coxhead, 2006), teachers may be able to boost the target vocabulary knowledge of at-risk students strategically in a way that minimizes the overall effects of the Matthew effect, at least in key content areas identified by teachers. Finally, research suggests that direct instructional approaches for teaching vocabulary are effective at accelerating the learning of young students, especially for words targeted for instruction and comprehension of passages that include target words (Marulis & Neuman, 2010).

Our approach to direct vocabulary instruction was informed by the work of Isabel Beck and Margaret McKeown (Beck et al., 2002) and incorporated the following principles: (a) a focus on high-utility academic vocabulary that occurs across content areas, (b) student-friendly definitions, (c) multiple exposures to words across different meaningful contexts, and (d) extended opportunities to interact with vocabulary to promote deep processing (see also Stahl, 1986). We developed and refined our approach, which we called extended vocabulary instruction, over a series of studies (Coyne et al., 2007, 2009, 2010).

Across studies we found that direct and extended vocabulary instruction resulted in greater breadth and depth of word learning than instruction that was less intensive, less interactive, and more incidental. We also found that compared to a business-as-usual comparison group (Coyne et al., 2010), students who received direct and extended vocabulary instruction experienced greater target vocabulary learning and listening comprehension of passages that included target words. We were encouraged by these findings, which suggested that direct and intentional instruction could accelerate the learning of vocabulary targeted for instruction of kindergarten students at risk for language and learning difficulties.

Because we were interested in whether direct vocabulary instruction could narrow the vocabulary gap on our measures of target vocabulary and listening comprehension, we also evaluated whether our intervention was differentially effective—whether some students responded more strongly to instruction than others. Across studies we found that overall receptive vocabulary measured prior to the start of the intervention by the Peabody Picture Vocabulary Test (PPVT) was highly predictive of target word learning during the course of the instruction and that in our quasi-experimental study, entry-level PPVT moderated the impact of the intervention. This finding of overall positive effects of vocabulary instruction in the early grades, but differential response based on initial vocabulary and language skills, was not unique to our team (Blewitt, Rump, Shealy, & Cook, 2009; Ewers & Brownson, 1999; Kan & Kohnert, 2012; Lugo-Neris, Jackson, & Goldstein, 2010; Penno et al., 2002; Silverman, Crandell, & Carlis, 2013)

In summary, our research, as well as the research of others, provided evidence that not only does the Matthew effect hold true for incidental learning of vocabulary, but it also influences learning during intentional direct vocabulary instruction. In other words, Matthew effects are not evident only on standardized measures that assess overall vocabulary development over time, but they also appear on experimenter-developed measures that assess response to vocabulary instruction. This finding should not have been surprising and is in fact consistent with the mechanism explaining the Matthew effect—even in a highly controlled instructional environment, students with larger vocabularies are able to leverage existing knowledge to more efficiently learn target vocabulary and are better able to incorporate taught vocabulary into their lexicons by building on strong existing lexical connections and representations.

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Our results, which converged with existing research, suggested that although all students benefited from explicit and extended vocabulary instruction, students with larger initial vocabularies benefited more than students with smaller initial vocabularies. Students at risk for language and learning difficulties experienced significantly greater target word learning than their at-risk peers who did not receive vocabulary instruction; however, they experienced significantly less word learning than their not-at-risk peers who received instruction. A universal approach to vocabulary instruction (i.e., whole-class instruction designed for all students), therefore, did not narrow the vocabulary gap among students who received instruction but, in fact, may have helped to widen it.

Supporting Vocabulary Development Within an MTSS Framework

These findings challenged us to revisit our overall approach for supporting the vocabulary learning of young students at risk for language and learning difficulties—those students most at risk for experiencing the impacts of Matthew effects. Instead of focusing solely on a universal or whole-class approach to vocabulary instruction, we began to think about a supporting vocabulary learning within a multitiered-system-of-support (MTSS) framework, also referred to as response to intervention (RTI; Vaughn & Fuchs, 2003; Fuchs & Fuchs, 2009; Gersten et al., 2009; National Center on Response to Intervention, 2010).

The logic of MTSS is grounded on the assumption that not all students respond similarly to even high-quality differentiated-classroom, or Tier-1, instruction. Therefore, some students at risk for learning difficulties will require targeted supplemental, or Tier-2, intervention in addition to classroom instruction to achieve desired learning outcomes—outcomes that are similar to their not-at-risk peers. A final assumption of MTSS logic is that schools can accurately identify students who are at risk for not responding adequately to Tier-1 classroom instruction through universal screening measures that predict future performance, so that intervention can be delivered preventively and strategically.

We believed that findings from our previous research met the conditions for considering an MTSS framework as a promising approach for supporting the vocabulary development of kindergarten students at risk for language and learning difficulties and lessening the effects of the vocabulary gap (Coyne et al., 2010). First, our research suggested that not all students benefited equally from a universal, or Tier-1, approach to vocabulary instruction. Students with larger initial vocabularies responded more strongly to Tier-1 instruction than students with smaller initial vocabularies. Second, we were able to predict which students were most at risk for not responding to classroom vocabulary instruction by examining receptive vocabulary knowledge measured at pretest. Finally, we hypothesized that students identified as at risk would respond positively to supplemental small-group vocabulary intervention based on findings from our research and the larger body of vocabulary intervention research.

Table 1. Demographic Information and Descriptive Statistics (Means and Standard Deviations).

Variable	Treatment	Control	Reference
Female	42.2%	39.4%	44.7%
Male	50.2%	48.1%	38.9%
Unknown	7.6%	7.2%	6.7%
White	17.8%	19.2%	29.9%
Black	20.5%	18.1%	17.0%
Latino/a	39.2%	36.7%	24.6%
Other	7.8%	10.8%	10.3%
Unknown	14.7%	9.9%	8.5%
Pretest			
PPVT	84.17 (5.10)	84.36 (5.24)	100.88 (2.60)
ETW	0.84 (1.39)	0.85 (1.54)	2.24 (2.40)
Posttest			
PPVT	91.54 (8.98)	91.39 (9.48)	103.20 (8.43)
ETW	18.69 (11.82)	8.27 (7.06)	13.78 (8.42)
LC	34.07 (19.19)	26.96 (15.45)	39.71 (16.43)
N	825	781	741

Note. PPVT = Peabody Picture Vocabulary Test-4; ETW = Expressive Target Word Measure; LC = Listening Comprehension Measure.

Our team began a new program of research to develop and evaluate a supplemental intervention to support the vocabulary learning of kindergarten students at risk for language and learning difficulties within an MTSS approach. We developed our small-group Tier-2 vocabulary intervention to reteach and reinforce the vocabulary taught in Tier-1 classroom instruction through highly engaging activities designed to promote depth of understanding and extended language use. Our intervention provided students with multiple opportunities for interactions with target vocabulary across different supportive contexts with immediate corrective feedback.

In a series of two studies, an efficacy study and a replication study (Coyne, 2016), kindergarten teachers provided 20 min of whole-group direct vocabulary instruction per day to all students in their classrooms over 22 weeks. Half of the at-risk students in these classrooms were also randomly assigned to receive our supplemental Tier-2 small-group vocabulary intervention. We also identified a reference group of not-at-risk students who received only Tier-1 instruction. Our primary research questions were whether the small-group vocabulary intervention had an impact on at-risk students' vocabulary and comprehension outcomes and whether supplemental Tier-2 vocabulary intervention would accelerate the learning of at-risk students who received supplemental vocabulary intervention so that it would be comparable with their not-at-risk peers in the reference group.

Results of multilevel analyses found a statistically significant impact of our intervention in both the efficacy and replication studies for at-risk treatment students who received both Tier-1 instruction and Tier-2 intervention on an experimenter-developed measure of expressive target word learning as well as a measure of listening comprehension of passages containing taught vocabulary compared to at-risk control students who received only Tier-1 vocabulary instruction. There were no differences on standardized measures of overall vocabulary knowledge. In addition, at-risk students who received both Tier-1 instruction and Tier-2 intervention demonstrated target word learning that was equal to, or greater than, their not-at-risk peers who received Tier-1 instruction. These findings are represented descriptively in Table 1.

Purpose of the Study

Although small-group vocabulary intervention that supplemented classroom instruction did not impact the overall general vocabulary knowledge of students at risk for language and learning difficulties, the intervention lessened the Matthew effect for listening comprehension of passages containing taught vocabulary and seemed to close the vocabulary gap for target words that were taught directly in Tier-1 classroom instruction and reinforced in Tier-2 intervention. However, our analyses focused on mean differences across groups. Because our previous research suggested that overall receptive vocabulary knowledge assessed by the PPVT moderated response to universal whole-class vocabulary instruction, we were interested in whether that finding would replicate for our small-group Tier-2 vocabulary intervention. If moderation was present, as we hypothesized, we were also interested in how this finding would temper the potential benefits of supporting vocabulary learning within an MTSS framework.

Method

Participants

Our efficacy and replication studies took place in 48 elementary schools located in a mix of urban, suburban, and rural districts in the eastern and northwestern United States. All 284 kindergarten classes in these schools participated in the study.

Early in the school year, we administered the PPVT to all kindergarten students in participating classrooms (N = 6,360) to determine their entry-level receptive vocabulary knowledge. Students who scored below a standard score of 92 (30th percentile) on the PPVT were considered at risk for language and learning difficulties and eligible to participate in the study. We identified clusters of at-risk students within each kindergarten classroom (n = 6–8) and created subclusters of three or four students within each cluster that were matched on initial PPVT scores. Then, within each cluster (classroom), one subcluster was randomly assigned to the treatment group, and the other was assigned to the control group. Occasionally, when there were very few eligible students within a school, the clusters spanned multiple kindergarten classrooms. Students in the treatment condition (n = 825) received the small-group supplemental Tier-2 Early Vocabulary Intervention (EVI) in addition to the classroom Tier-1 vocabulary instruction. Students in the control condition (n = 781) received only classroom Tier-1 vocabulary instruction.

We also identified three or four students from each classroom whom we considered typical achievers (n = 741) to serve as a not-at-risk reference group. These students were chosen based on an initial PPVT score that fell between standard scores of 95 and 105 (37th and 67th percentiles). Students in the reference group received only classroom Tier-1 vocabulary instruction. Student demographic information for each of these groups is provided in Table 1. There were no statistically significant differences between treatment and control groups on any of the demographic variables or pretest assessments.

All teachers (N = 182) in participating classrooms provided whole-class vocabulary instruction to all their students. Most of the teachers were female (96.7%), and they described themselves as White (84.0%), Black (10.4%), Hispanic (5.5%), and Other (<1.0%). Teachers received a full day of professional development focused on effective vocabulary instruction and on implementing whole-class vocabulary instruction with fidelity.

Schools identified interventionists (N = 133) from among their staff to provide the Tier-2 EVI intervention. Interventionists included paraprofessionals, certified teachers, reading teachers, and other professionals. Of the interventionists, 67.0% held a college degree and the remainder held high school diplomas. Most of the interventionists were female (95.9%), and they described themselves as White (75.7%), Black (11.4%), Hispanic (11.4%), and Other (1.4%). Interventionists received a full day of professional development focused on implementing the Tier-2 EVI intervention and were provided with additional coaching during the course of the intervention. (More participant information can be found in Coyne, 2016.)

Tier-1 Classroom Vocabulary Instruction

To standardize Tier-1 classroom instruction, teachers in participating classrooms implemented the Elements of Reading Vocabulary (EOR-V) program, a commercially available curriculum with evidence of efficacy (e.g., Apthorp et al., 2012), which provided teachers with a set of 24 weekly vocabulary lessons and accompanying materials. Lessons were delivered in a 5-day sequence for about 20 min each day. The Tier-1 vocabulary curriculum focused on teaching high-utility academic vocabulary that occurs across content areas. Over the course of the week, students had multiple opportunities to use the newly learned words and definitions in a series oral, listening, and workbook-based activities.

Tier-2 Supplemental Vocabulary Intervention

Students who were assigned to the intervention group received the Tier-2 supplementary EVI intervention in addition to Tier-1 classroom instruction. EVI was implemented in small groups of three or four students outside of the classroom for 30 min per day, 4 days per week, over the course of approximately 22 weeks.

EVI was developed to align with the Tier-1 classroom vocabulary lessons and to emphasize features of effective instruction that have been demonstrated to enhance students' vocabulary learning (Beck et al., 2002; Coyne et al., 2009). Interventionists provided explicit instruction with extensive teacher modeling and multiple opportunities for students to practice using the target vocabulary words introduced during Tier-1 classroom instruction. They modeled using the words in sentences and provided scaffolding to students to elaborate when crafting their own sentences with the newly learned words. Interventionists provided specific feedback targeted to individual student learning needs.

The EVI intervention supported extended language use as well as review of the target vocabulary. Interactive activities provided students with opportunities to (a) discriminate between examples and nonexamples of pictures representing the target words, (b) use target words to describe pictures and to discuss personal experiences, (c) discuss connections between target vocabulary and other words and concepts, and (d) participate in meaningful conversations with peers about the target words. (More information about EVI can be found in Coyne, 2016.)

Fidelity of Implementation

Teachers. To document fidelity of implementation of the Tier-1 classroom vocabulary instruction, we designed a checklist to assess whether or not teachers completed each of the EOR-V activities. We observed teachers at least three times over the course of the study. Teachers delivered complete lessons 81.6% of the time.

Interventionists. The research team provided ongoing support and coaching to interventionists and conducted formal observations using a checklist designed to assess whether or not they completed each of the EVI activities as well as to assess the quality of instruction they provided. The fidelity checklist was used to evaluate interventionists at least three times over the course of the study. Interventionists completed activities 87.9% of the time. The mean score for quality of instruction for interventionists was 0.94 on a scale of 1.0, demonstrating their consistent use of modeling, feedback, and opportunities to respond.

Measures

PPVT. The PPVT–Fourth Edition (Dunn & Dunn, 2007) is a norm-referenced, individually administered measure of receptive vocabulary. The student is presented with a set of four color pictures on each page of an easel. Students are asked to point to the picture that best represents the word spoken by the examiner. The test can be administered to ages 2.6 to 90+ years. Split-half reliabilities range from .89 to .97; test-retest correlations range from .92 to .96.

Expressive Target Word Measure. This researcher-developed measure is an individually administered assessment of students' knowledge of target word definitions. We selected 26 of 66 target words taught in the intervention to assess. The examiner asked the student, "What does [target word] mean?" Two points were awarded for complete and accurate responses, one point for partial and related responses, and zero points for an unrelated response or no response. Cronbach's alpha for the target word measure was .88.

Listening Comprehension Measure. The research team created a set of four stories and embedded four of the target vocabulary words in each story. Examiners read each story aloud to students individually while showing a set of corresponding pictures. Immediately after listening to the story, students were asked to answer four questions about the story. Questions were constructed so that students needed to call upon their knowledge of the target vocabulary words to correctly answer the questions. Two points were awarded for complete answers that used the target word or a synonym. One point was awarded for a plausible answer that did not use the target word or synonym, and zero points were awarded for an incorrect answer. Cronbach's alpha for the Listening Comprehension Measure was .76.

Data Collection and Scoring

Screening, pretest, and posttest assessment were administered to students individually by trained research staff, who were required to demonstrate 90% reliability for administration and scoring of each measure. Screening and pretest measures were administered in the fall before the start of the intervention, and posttest measures were administered in the spring within 2 to 3 weeks of the end of the intervention.

Data Analyses

To examine whether PPVT moderated the treatment effect, we fit a series of four-level multilevel models on selected outcome variables of interest: the researcher-developed Expressive Target Word Measure, the Listening Comprehension Measure, and posttest PPVT. The reference group students, who represented a different subpopulation of students with substantially higher pretest scores, were not included in the multilevel models. However, we were interested in determining whether students who received the Tier-2 intervention could "catch up" to their not-at-risk classmates. Therefore, we include the results of the reference group to provide a point of reference and to determine the practical effect of the treatment.

We treated students (Level 1) as nested within subclusters (Level 2), which were nested within clusters, which were nested within schools (Level 4). The full model included treatment (at Level 2), group-mean-centered fall PPVT score (at Level 1), and the cross-level interaction between PPVT and treatment. PPVT was group-mean centered at the student level (Level 1). Therefore, to preserve the between-cluster information contained in the original variable, PPVT was included at the higher levels as well, group-mean centered at Levels 2 and 3, and grand-mean centered at Level 4. All four coefficients for PPVT are presented in Table 2. However, the coefficient of greatest interest is the cross-level interaction between the group-mean centered PPVT score (at Level 1) and treatment (at Level 2). For all models, we allowed the intercept to randomly vary across subclusters, clusters, and schools; however, we did not allow the any of the PPVT slopes to randomly vary across subclusters, clusters, or schools.

$$\begin{aligned} Y_{ijkl} = {} & \gamma_{0000} + \gamma_{1000}(\text{TRT}) + \gamma_{2000}(\text{PPVT}) \\ & + \gamma_{3000}(\text{PPVT} * \text{TRT}) + m_{000l} + u_{00kl} \\ & + r_{0jkl} + e_{ijkl}, \end{aligned}$$

where i indexes the students within subclusters, j indexes the subclusters within clusters, k indexes the clusters within schools, and l indexes the schools.

Table 2. Multilevel Results: Expressive Target Word Measure, Listening Comprehension, and Spring PPVT Score.

	Expressive Target Word Measure		Listening Comprehension		Spring PPVT	
Variable	*b*	*SE*	*b*	*SE*	*b*	*SE*
Intercept	8.13	0.65	26.87***	0.94	91.3***	0.34
PPVT subc	0.29***	0.06	0.80***	0.15	0.78***	0.07
PPVT clusterc	0.57	0.32	1.08*	0.52	0.45	0.23
PPVT school c	0.35	0.18	0.91**	0.30	0.82***	0.14
School PPVT	0.92**	0.30	1.39**	0.43	1.21***	0.15
TRT	10.46***	0.62	7.14***	0.98	0.27	0.43
TRT × PPVT	0.28**	0.09	0.53*	0.21	−0.02	0.09

Note. PPVT = Peabody Picture Vocabulary Test; PPVT subc = student's PPVT score, group-mean centered around the subcluster mean; PPVT clusterc = subcluster mean PPVT score, group-mean centered around the cluster mean; PPVT school c = cluster mean PPVT score, group-mean centered around the school mean; School PPVT = grand-mean-centered school mean PPVT score; TRT = treatment; TRT × PPVT is the Treatment × PPVT interaction term. This is the interaction of the PPVT subc (the group-mean-centered PPVT score at Level 1 and treatment, which is coded 0 = control, 1 = treatment.).
**p* < .05. ***p* < .01. ****p* < .001.

Table 3. Variance (Var) Components.

	Expressive Target Word Measure		Listening Comprehension		Spring PPVT	
Variable	Var	*SE*	Var	*SE*	Var	*SE*
Tau school	9.09**	3.03	13.07*	5.89	0.32	0.65
Tau cluster	1.81	3.25	8.00	7.59	3.42*	1.72
Tau subcluster	22.14***	4.11	6.62	9.49	0.20	1.95
Sigma square	57.24***	2.57	244.73***	12.13	62.96***	2.76

Note. PPVT = Peabody Picture Vocabulary Test.
**p* < .05. ***p* < .01. ****p* < .001.

Results

Attrition

Of the 2,347 students who were assigned to the treatment, control, or reference groups, 248 left the study, meaning that they did not complete the Expressive Target Word Measure in spring of their kindergarten year. This represents an attrition rate of 10.57%. Of those, 176 were assigned to the treatment or control groups. Attrition was balanced across the treatment and control groups, with 88 students missing spring data in both groups. The mean fall kindergarten PPVT score for control students with missing spring Expressive Target Word Measure scores was 84.36 and was 84.37 for treatment students, indicating an apparent lack of differential attrition.

Expressive Target Word Measure

We examined whether PPVT moderated the effect of the Tier-2 intervention on students' performance on the Expressive Target Word Measure. The parameter estimates for this model, presented in Table 2, indicate that PPVT did moderate the treatment effect. Although treatment students outperformed control students on target word knowledge (γ_{1000} = 10.46), the effect of the treatment was more pronounced for students with higher initial PPVT scores (γ_{3000}= 0.28). Figure 1 graphs the expected treatment effect. Figure 2 graphs the Johnson-Neyman confidence

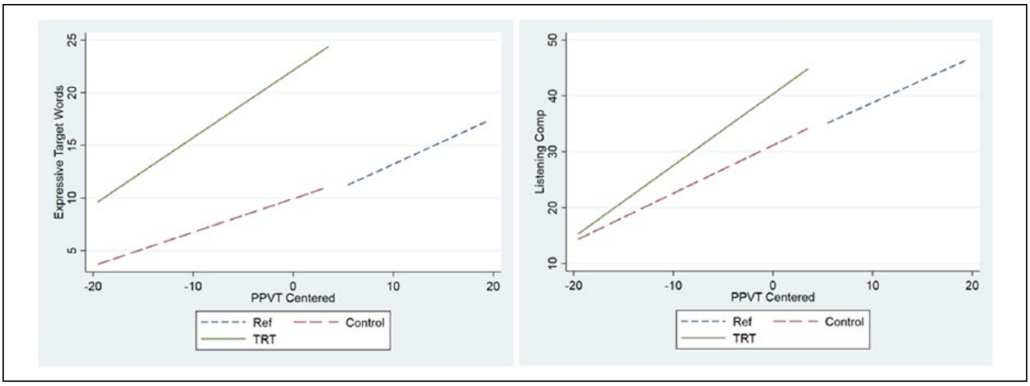

Figure 1. Relationship between fall Peabody Picture Vocabulary Target, target word outcomes, and listening comprehension outcomes for treatment, control, and reference groups.

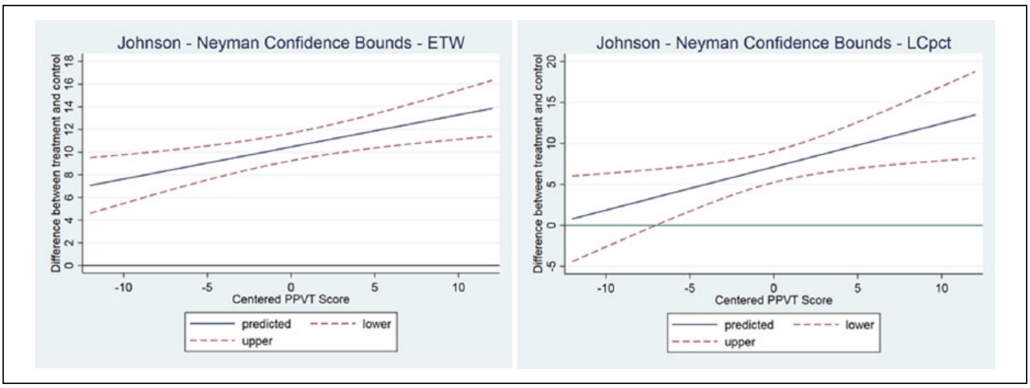

Figure 2. Johnson-Neyman confidence bounds for the impact of the treatment on target word and listening comprehension outcomes.

bounds, visually depicting the moderational effect of initial PPVT on the impact of the treatment on target word knowledge. Because the lower confidence bound does not dip below zero, the effect of the Tier-2 intervention on target word knowledge is statistically significant for students across the entire range of initial PPVT scores.

To quantify the magnitude of the treatment effect for students with different initial PPVT scores, we computed Hedge's *g* standardized effect sizes at 5 points below the mean, at the mean, and at 5 points above the mean, using the model-based estimates. Because the standard deviation of fall PPVT scores was approximately 5 points in the treatment and control groups, these standardized effect sizes represent predicted treatment effects for at-risk students who scored one standard deviation below the mean, at the mean, and one standard deviation above the mean. Although the overall mean effect size for the impact of the intervention was 1.07, for students with fall PPVT scores 5 points below the mean, the effect size was .92; and for students with fall PPVT scores 5 points above the mean, the effect size was 1.21. The differential impact of the intervention associated with moderation on target word outcomes is presented in Table 4 and in Figures 1 and 2.

We also examined the degree to which the Tier-2 intervention closed the gap between at-risk students and their not-at-risk peers on target word knowledge. Given that there was no overlap in the PPVT scores of the Tier-2 eligible students and the reference group students, we did not include the reference

Table 4. Comparisons of Treatment, Control, and Reference Students on Experimenter-Developed Measures of Expressive Target Word Knowledge and Listening Comprehension

	Assignment				
Measure	Treatment mean	Control mean	Reference mean	Hedge's *g* treatment/ control	Hedge's *g* treatment/ reference
Expressive Target Word Measure					
Fall PPVT 5 points below mean	15.69	6.79	13.78	0.92	.19
Fall PPVT at mean	18.74	8.44	13.78	1.07	.47
Fall PPVT 5 points above mean	21.79	9.89	13.78	1.21	.77
Listening Comprehension Measure					
Fall PPVT 5 points below mean	27.77	22.58	39.71	0.26	−.69
Fall PPVT at mean	34.07	26.96	39.71	0.41	−.34
Fall PPVT 5 points above mean	40.37	31.28	39.71	0.56	.05

Note. PPVT = Peabody Picture Vocabulary Test. For the effect sizes, reference students are always compared at their mean, which is 13.78 for the Expressive Target Word Measure and 39.71 for the Listening Comprehension Measure. The Hedge's *g* comparisons of the treatment and control groups are based on the model-predicted scores.

students in our main multilevel analyses. However, descriptive reference group comparisons provide several interesting insights. First, the treatment group outperformed the reference group by nearly 5 points on the posttest Expressive Target Word Measure in the spring of kindergarten. This represents a Hedge's *g* effect size of 0.47. However, the difference between the at-risk treatment students and not-at-risk reference students varied as a function of the at-risk students' initial vocabulary knowledge. For treatment students with fall PPVT scores 5 points below the mean, the effect size compared to the mean of the reference group was 0.18; treatment students with fall PPVT scores 5 points above the mean scored 0.77 standard deviation units higher on average than reference students did. At-risk treatment students generally performed as well as, or better than, the reference group, suggesting that the intervention helped to boost treatment students into the normative range. In fact, 82.2% of the treatment students scored at or above the 25th percentile of the reference group, and 68.7% scored at or above the 50th percentile. In contrast, only 44.7% and 25.7% of control students scored at or above the 25th and 50th percentiles of the reference group, respectively.

Second, the relationship between initial PPVT score and expressive target word learning was virtually identical in the control and reference groups. Therefore, there appears to be a similar positive association between initial general vocabulary knowledge and response to universal, Tier-1 vocabulary instruction for all students in our study who received only whole-class instruction, consistent with Matthew effects. The association between entry-level vocabulary knowledge measured in the fall of kindergarten and target word outcomes for all three groups (treatment, control, and reference) is illustrated in Figure 1.

Listening Comprehension Measure

Next, we examined whether PPVT moderated the effect of the Tier-2 intervention on students' listening comprehension. The parameter estimates for this model are presented in Table 2. Again, PPVT did moderate the treatment effect. Although treatment students had overall higher listening comprehension scores than control students (γ_{1000} = 7.14), the effect of the treatment was more pronounced for students with higher initial PPVT scores (γ_{3000} = 0.53). Figure 1 graphs the expected treatment effect. Figure 2 demonstrates the Johnson-Neyman confidence bounds for the treatment effect on listening comprehension. The effect of treatment on listening comprehension was statistically significant for at-risk students whose initial PPVT scores were less than 7 points below the mean but not statistically significant for students whose initial PPVT scores were more than 7 points below the mean. Similar to target word learning, we illustrate the differential impact of the Tier-2 intervention on listening comprehension using Hedge's *g* standardized effect sizes in Table 4. Although the overall mean effect size for the impact of the intervention on listening comprehension was 0.41, for students with initial PPVT scores 5 points below the mean, the effect size was 0.26; and for students with scores 5 points above the mean, the effect size was 0.56.

We were also interested in comparing listening comprehension outcomes between at-risk treatment students and the not-at-risk reference group on listening comprehension. On average, treatment students had listening comprehension scores that were approximately one third of a standard deviation lower than the mean of the reference students ($g = -.34$). However, at-risk treatment students with initial PPVT scores 5 points above the mean scored comparably to the reference students ($g = .05$). In contrast, the gap between treatment and reference students was wider for treatment students with PPVT scores 5 points below the mean ($g = -.69$).

Finally, 60.4% of students in the treatment group scored at or above the 25th percentile of the reference group, and 41.5% scored above the 50th percentile on the Listening Comprehension Measure compared with 48.3% and 27.1% of control group students. The association between entry-level vocabulary knowledge measured in the fall and listening comprehension outcomes for all three groups (treatment, control, and reference) is illustrated in Figure 2. Again, there appears to be a similar positive association between initial general vocabulary knowledge and response to universal, Tier-1 vocabulary instruction on listening comprehension outcomes for all students in our study who received only classroom instruction (i.e., control and reference students).

Overall Vocabulary Knowledge (PPVT)

In contrast to the findings for our more proximal measures, we found no overall effect of treatment on students' posttest PPVT scores. Compared to the normative sample of the PPVT, 53.5% of the treatment students scored at or above the 25th percentile at posttest, and 19.3% scored at or above the 50th percentile. This is similar to the control group in which 51.9% and 19.5% of students were at or above the 25th and 50th percentiles, and comparable to pretest performance. Although fall PPVT scores were strong predictors of spring PPVT scores, the Treatment × PPVT interaction was not statistically significant. These results are in Table 2.

Discussion

In our series of two studies, we found that at-risk kindergarten students who received Tier-2 vocabulary intervention that supplemented Tier-1 whole-class instruction outperformed the at-risk students who received only the Tier-1 classroom instruction on measures of target word learning and listening comprehension of passages that included target words. Additionally, at-risk students who received both Tier-1 instruction and Tier-2 intervention demonstrated greater target word learning than their not-at-risk peers who received Tier-1 instruction. There were no differences on standardized measures of overall vocabulary knowledge.

In our series of two studies, we found that at-risk kindergarten students who received Tier-2 vocabulary intervention that supplemented Tier-1 whole-class instruction outperformed the at-risk students who received only the Tier-1 classroom instruction on measures of target word learning and listening comprehension of passages that included target words.

In our previous research, however, we found that individual differences in vocabulary knowledge at pretest both predicted and moderated learning gains from universal vocabulary instruction, with students with larger initial vocabularies benefiting more (e.g., Coyne et al., 2010). We were interested in whether this finding would replicate in our most recent studies—whether overall receptive vocabulary knowledge would moderate the impact of our supplemental vocabulary intervention. In addition, we were interested in whether moderation would require us to reinterpret or qualify our findings that Tier-2 intervention accelerated the target word learning and listening comprehension of at-risk students compared to not-at-risk peers.

Results indicated that individual differences in overall receptive vocabulary knowledge measured at pretest on the PPVT did moderate the impact of our Tier-2 intervention on experimenter-developed measures of expressive vocabulary learning and listening comprehension. The effect of moderation can be seen in the differential impact of the intervention for students with different levels of overall vocabulary knowledge measured at pretest. Differential response to the intervention can be seen in Table 4, by examining the differences in effect sizes for treatment students with initial PPVT standard scores 5 points above and 5 points below the mean, as well as in Figures 1 and 2.

Effects Compared to Reference Students

These findings were not unexpected. We have consistently found that individual differences in PPVT measured at pretest both predict posttest outcomes and moderate the impact of direct vocabulary instruction. In fact, we conceptualized our current research to try to lessen the consequences of this differential responsiveness and effectiveness by providing students who were at risk for not responding to classroom vocabulary instruction with supplemental intervention. We hoped that the additional dosage and intensity would help to compensate for differential responsiveness to universal, whole-class Tier-1 instruction by boosting the target word learning of the at-risk students, particularly compared to their not-at-risk peers. However, we wondered whether Matthew effects were strong enough to continue to significantly influence the learning outcomes of the most at-risk students, even with the provision of supplemental intervention—in a sense, offsetting the benefits of receiving Tier-2 intervention.

Even though response to the Tier-2 intervention was moderated by initial vocabulary knowledge, the intervention was powerful enough to boost the target word learning of at-risk students, regardless of initial vocabulary knowledge, to levels well above the control group and comparable to their not-at-risk peers.

Although we did find that on average, at-risk students who received supplemental intervention closed the gap between themselves and their not-at-risk peers for target word learning, we also found evidence of differential responsiveness to the Tier-2 intervention. At-risk students in the treatment group with higher initial vocabulary knowledge demonstrated differentially greater word learning than students with lower initial vocabulary knowledge compared to the at-risk students in the control group. However, even at-risk students with lower initial vocabulary knowledge who received the Tier-2 intervention experienced statistically significantly greater target word learning than at-risk control group students who received only Tier-1 instruction. Moreover, 82.2% of at-risk students who received Tier-2 intervention scored above the 25th percentile, and 68.7% scored above the 50th percentile of the target word score of the not-at-risk reference students, who were selected based on average pretest vocabulary knowledge (e.g., 50th percentile). In other words, even though response to the Tier-2 intervention was moderated by initial vocabulary knowledge, the intervention was powerful enough to boost the target word learning of at-risk students, regardless of initial vocabulary knowledge, to levels well above the control group and comparable to their not-at-risk peers. At least for target word learning, the Matthew effect did not appear to be strong enough to negate the benefits of supplemental vocabulary intervention, even for the most at-risk students.

The pattern of findings was different for listening comprehension. Again we found differential responsiveness to the Tier-2 intervention, favoring students with higher initial vocabulary knowledge. However, the treatment effect was more modest, and there was a statistically significant impact of the intervention only for treatment students whose initial PPVT scores were at or above 7 points below the mean. Additionally, in contrast to findings for target word learning, the ability of the Tier-2 intervention to close the gap between at-risk students and their not-at-risk peers on the listening comprehension measure also depended on their pretest PPVT scores. Whereas even at-risk students with lower initial vocabulary knowledge experienced target word learning similar to their not-at-risk peers, only 60.4% and 41.5% of at-risk students, generally those with relatively higher levels of initial vocabulary knowledge, scored above the 25th and 50th percentile, respectively, compared to the listening comprehension score of the not-at-risk reference students.

Implications

Findings of this study help illuminate both the benefits and challenges of providing early vocabulary instruction and intervention within an MTSS framework. First, it is important to note that our Tier-2 vocabulary intervention did not have an impact on standardized measures of vocabulary knowledge and did not close the substantial gap among students on overall vocabulary knowledge. However, results support the advantages of providing early vocabulary instruction and intervention within an MTSS framework for supporting important targeted language and vocabulary outcomes (Coyne et al., 2010). By identifying students who were at greatest risk for not responding to classroom vocabulary instruction, we were able to lessen Matthew effects for these students on experimenter-developed measures of target word learning and listening comprehension of passages that included target words by proactively and preventively increasing the intensity of vocabulary instruction through supplementing classroom instruction with small-group intervention. However, findings from moderation analyses revealed that individual differences in overall vocabulary knowledge measured at the beginning of kindergarten continued to exert a strong influence over response to small-group vocabulary intervention.

The largest impact of the intervention was on target word learning, and this was also the outcome that was less influenced by Matthew effects. Students identified as at risk who received supplemental intervention that reinforced target vocabulary introduced during general classroom instruction demonstrated accelerated word learning that was generally equal to, or greater than, that of their not-at-risk peers, and this learning was not offset by differential responsiveness to the intervention. However, achieving these outcomes required a significant investment in time and resources. Students who received Tier-2 vocabulary intervention were provided with approximately double the amount of instructional time compared to students who received only whole-class classroom vocabulary instruction. Students also received intervention in small groups of three or four, which required schools to identify and train interventionists as well as schedule time for intervention.

Converging evidence suggests that direct vocabulary instruction can have a large impact on students' learning of words targeted for instruction (Coyne et al., 2010; Marulis & Neuman, 2010). Because of the significant instructional investment and relatively small number of words that can be taught using a rich, extended approach, however, selection of words to teach is key.

Schools and teachers need to select high-leverage academic vocabulary to teach directly that provides the biggest bang for the buck. We do not yet have a validated "curriculum" of vocabulary that all students should learn that will in turn stimulate and accelerate future learning. However, there is guidance on how to select vocabulary to teach (Beck et al., 2001), and lists of academic vocabulary are becoming more widely available (e.g., Biemiller, 2010; Coxhead, 2006).

Direct vocabulary intervention also had an impact on students' listening comprehension of stories that included target vocabulary words, and supplemental intervention helped to narrow the learning gap among students. However, unlike target word learning, individual differences in overall vocabulary knowledge moderated the impact of the intervention considerably. It appears that Matthew effects continue to be more pronounced on distal outcomes, like comprehension, that are influenced by broader language abilities above and beyond knowledge of words taught directly during intervention (Stanovich, 1986).

Because of differential responsiveness, there were students with lower levels of initial vocabulary knowledge who did not benefit from supplemental vocabulary intervention or who benefited compared to the at-risk control group but whose listening comprehension outcomes continued to lag far behind their not-at-risk peers. In other words, Tier-2 intervention that supplemented Tier-1 classroom instruction did not compensate for the Matthew effect; it was not intensive enough to accelerate the listening comprehension of the majority of at-risk students so that it was comparable to their not-at-risk peers. There were some students who did not respond adequately to even high-quality Tier-1 instruction supplemented by intensive Tier-2 intervention.

In MTSS frameworks, students who do not respond to intervention receive more targeted, individualized intervention at higher levels of intensity, often described as Tier 3. Although small-group Tier-2 intervention may be enough to close learning gaps for some students, results of this study suggest that students with lower overall language abilities may need highly intensive Tier-3 intervention to accelerate broader language development.

Summary

Stanovich's (1986) conceptualization of the Matthew effect continues to provide a powerful framework for understanding not only vocabulary development but also response to vocabulary instruction and intervention. Consistent with the Matthew effect, results of this study provide additional evidence that individual differences in overall receptive vocabulary knowledge measured at the beginning of the school year are a strong predictor of response to vocabulary instruction and moderate the impact of supplemental vocabulary intervention.

Although we may not be able to design universal vocabulary instruction that will benefit all students equally, MTSS frameworks offer a promising approach for providing different levels of language and vocabulary support to students based on their level of risk. By screening kindergarten students at the beginning of the year and identifying those students who we predicted would be less responsive to universal, Tier-1 classroom vocabulary instruction, we were able to provide students with timely, intensive, small-group intervention that helped to close gaps between them and their not-at-risk peers.

However, students will still respond differentially to supports provided, even within a tiered framework, necessitating increasing levels of intensity (e.g., additional dosage, smaller group size, highly specified instructional design; Fuchs, Fuchs, & Malone, 2017). Educators will likely continue to see differential responsiveness to vocabulary instruction and intervention at any tier. Therefore, schools and teachers will be constantly engaged in a race against the Matthew effect—continually having to make hard decisions about how to leverage time, personnel, and resources to intensify instruction and intervention.

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ORCID iD

Michael D. Coyne https://orcid.org/0000-0001-6151-2534

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